

[54] **HYDRAULIC LEVELING CIRCUIT FOR IMPLEMENT**

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[51] Int. Cl. **E02f 3/87**

[58] Field of Search **214/762, 763, 764, 140**

[56] **References Cited**

UNITED STATES PATENTS

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[57]

ABSTRACT

The disclosure relates to a hydraulic circuit for a vehicle having a boom pivoted thereon by a boom ram and a bucket pivoted on the boom by a bucket ram. The hydraulic circuit includes a main pump that supplies fluid under pressure from a reservoir to the boom and bucket rams through control valves. An auxiliary circuit supplies fluid from the reservoir to the bucket ram to maintain the material handling unit at a predetermined attitude with respect to the reference plane and the auxiliary circuit includes a pump that is driven by the flow of fluid between the boom control valve and the boom ram.

13 Claims, 3 Drawing Figures

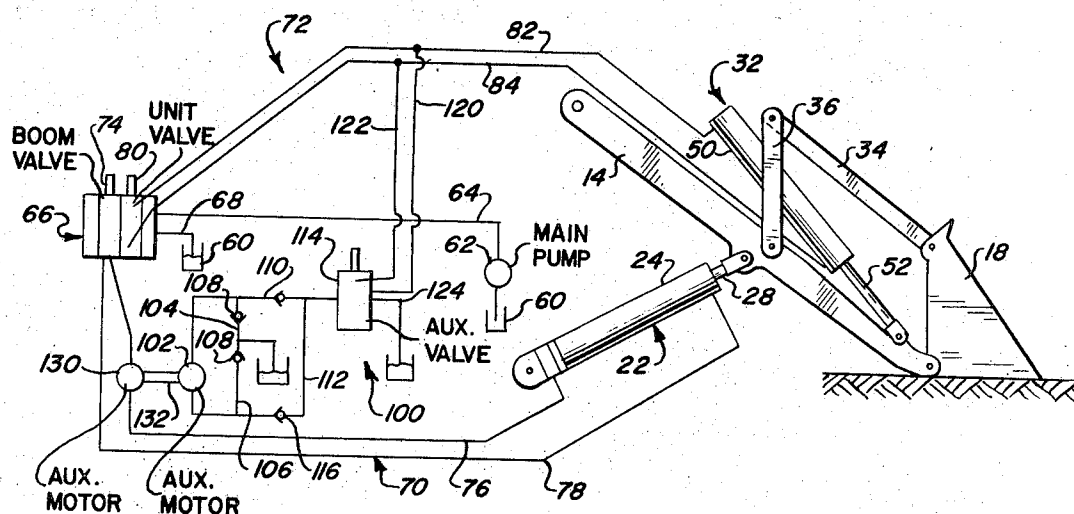


FIG. 1

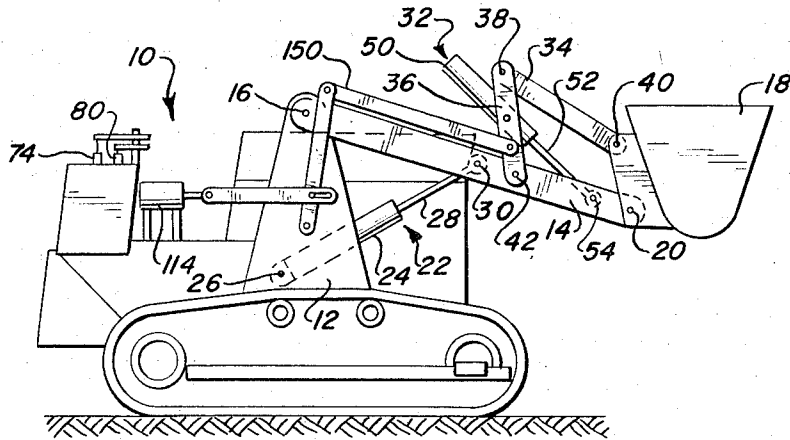


FIG. 2

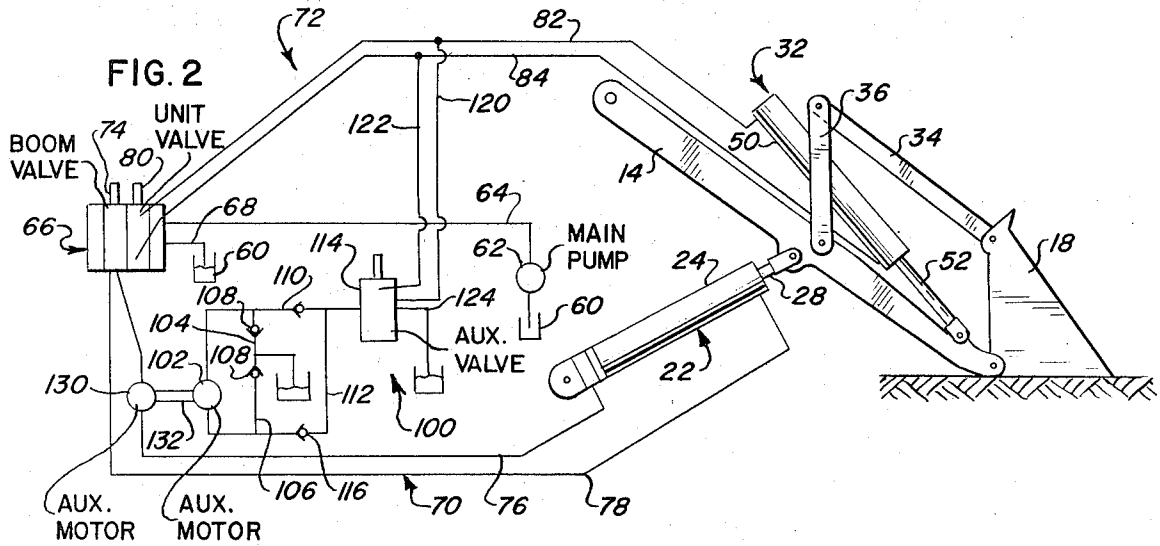
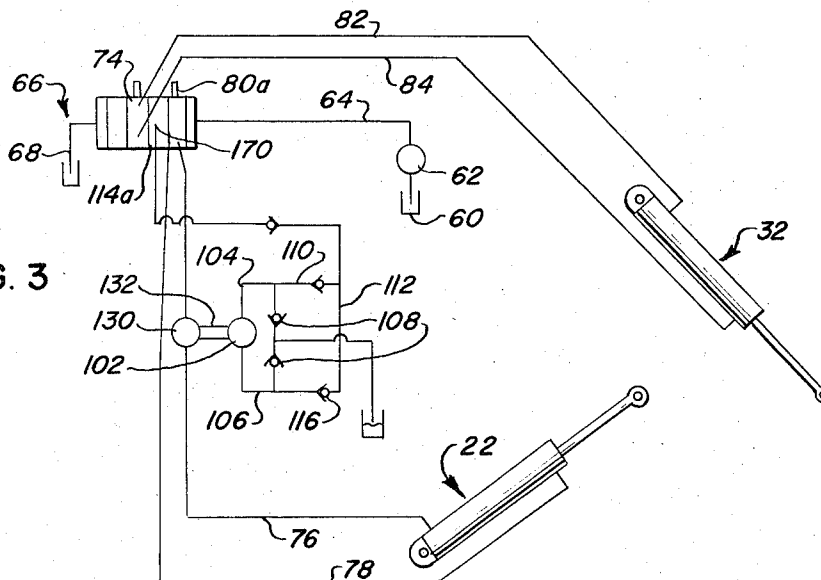


FIG. 3



HYDRAULIC LEVELING CIRCUIT FOR IMPLEMENT

ABSTRACT OF THE INVENTION

The present invention relates generally to material handling equipment and more particularly to improved method and apparatus for controlling the position of a bucket supported on a boom.

In conventional earth moving equipment, such as bucket loaders, the equipment generally includes one or more lift arms, generally referred to as a boom, pivotally carried on a vehicle with a bucket pivoted on the free end of the lift arms. Generally, the lift arms are raised and lowered on the vehicle by a fluid ram having fluid supplied thereto through a control valve while the bucket is pivoted on the end of the lift arms through an additional fluid ram having fluid supplied thereto through a further control valve. The fluid is generally supplied to the respective control valves from a reservoir through a pump.

In normal operation, the bucket or material handling unit is positioned in a "dig" position and is forced into a pile of material by forward movement of the vehicle. The bucket is then pivoted or rolled back on the boom or lift arms with sufficient force to break out the mass of material within the bucket from the remainder of the pile. Subsequently, the lift arms are elevated a sufficient distance to raise the bucket above the ground and the vehicle is driven to some other location. Upon reaching the subsequent location, the bucket is pivoted to a "dumping" position where the contents are discharged, after which the operation is repeated.

In an operation such as this, it is important that the bucket be maintained at a level position while the lift arms are being raised and lowered to prevent the material or contents from being spilled.

Many of the self-leveling devices take hydraulic fluid for leveling directly from the pump that also supplies fluid for raising and lowering the boom or lift arms.

In large units of this type, some difficulties have been encountered in having sufficient fluid available from the pump to allow the boom to be raised at its desired speed and at the same time provide the necessary amount of fluid for performing the leveling function for the unit as the boom or lift arms are being raised and lowered.

Other self-leveling systems utilize "slave cylinders" between the lift arms and the support and fluid is directed from these cylinders to the bucket fluid rams during the raising and lowering of the lift arms to produce the leveling function. However, the "slave cylinders" self-leveling requires heavy mounting points for the cylinders since they must absorb large forces developed by the hydraulic fluid as it is being transferred between the cylinders and bucket rams.

A further system includes links that are interposed between the support and the bucket and are usually carried by the lift arms to produce the leveling function. This type of system requires heavy links on top of the lift arms.

SUMMARY OF THE INVENTION

The present invention incorporates an auxiliary circuit into the normal hydraulic circuit for a vehicle mounted material handling unit. The auxiliary circuit supplies fluid for maintaining the unit at a level condi-

tion and the amount of fluid supplied is a function of the speed at which the boom is raised and lowered with respect to the vehicle.

The method of the present invention contemplates supplying fluid under pressure from a reservoir through a main pump to first and second control valves that are selectively actuated to respectively control the flow of fluid to and from a boom ram and a material handling unit ram. Fluid for maintaining the unit at a level condition during the raising and lowering of the boom is supplied through an auxiliary circuit that includes an auxiliary pump driven by fluid flowing between the boom ram and its associated valve to deliver fluid from the reservoir to the unit ram. In the specific method disclosed herein, the pump is a reversible pump that is driven by an auxiliary motor in one of the conduits between the boom ram and its associated valve so that fluid flow in either direction in the conduit will drive the pump.

The method of the present invention is performed with a hydraulic circuit that supplies fluid to a boom ram that is capable of raising and lowering a boom pivoted on a vehicle and a unit ram that is capable of pivoting a material handling unit on the boom. The hydraulic circuit includes a reservoir with pump means for supplying fluid under pressure from the reservoir. The hydraulic circuit also includes first hydraulic circuit means connecting the pump and reservoir to the boom ram and second hydraulic circuit means connecting the pump means and reservoir to the unit ram. The hydraulic circuit further includes auxiliary hydraulic circuit means cooperating with the first hydraulic circuit means and connected to the second hydraulic circuit means for supplying fluid under pressure from the reservoir to the unit ram and maintaining a predetermined attitude of the material handling unit with respect to a reference plane as the boom is raised and lowered on the vehicle. The auxiliary hydraulic circuit means incorporates an auxiliary pump that is driven by fluid flow in the first hydraulic circuit means to supply fluid to the unit motor for performing the leveling operation.

More specifically, the first hydraulic circuit means includes a boom control valve that is connected to the main pump and reservoir and to the boom ram through first and second conduits. The second hydraulic circuit means includes a unit control valve also connected to the main pump and to the reservoir as well as being connected to the unit motor through first and second conduits. The auxiliary hydraulic circuit means includes an auxiliary motor in one of the conduits between the boom control valve and the boom ram with the auxiliary pump as a function of the flow of fluid in one of the conduits. The auxiliary motor and pump are reversible and the auxiliary pump is connected to the reservoir through first and second conduits that each have check valve means therein to supply fluid from the reservoir in a unidirectional flow to opposite sides of the auxiliary pump and likewise connected to the unit ram so that fluid under pressure developed by the auxiliary pump is available for performing the leveling function of the material handling unit.

In one embodiment of the invention, the auxiliary pump is connected to the unit control valve which incorporates separate flow paths to allow fluid to be supplied from the control valve to the unit ram while in an alternative embodiment, a separate leveling control

valve or auxiliary valve is provided between the auxiliary pump and the unit ram.

The arrangement is such that the amount of fluid available for performing the leveling function is directly dependent upon the rate of movement of the boom, which in turn determines the amount of fluid required for performing the leveling function for the material handling unit.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF DRAWINGS

FIG. 1 is a schematic illustration of a vehicle having a boom pivoted thereon with a bucket pivoted on the boom with the hydraulic circuit of the invention incorporated therein;

FIG. 2 is a schematic illustration of the hydraulic circuit of the present invention; and

FIG. 3 is a slightly modified form of a hydraulic circuit.

DETAILED DESCRIPTION

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail two specific embodiments, with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiments illustrated.

FIG. 1 of the drawings generally shows the environment for the present invention and includes tractor or vehicle 10 having upright supports 12 on opposite sides thereof (only one being shown). Each upright has lift arm 14 pivotally supported at the upper end on pivot pins 16. The lift arms define what may be termed a boom which has material handling unit or bucket 18 pivotally supported about pivot pins 20. The lift arms or boom are adapted to be raised and lowered relative to the vehicle through boom ram 22 that consists of cylinder 24 pivoted on support 12 by pivot pin 26 with piston rod 28 pivoted on boom 14 by pivot pin 30. Again, two such boom rams are respectively attached between the two lift arms and the supports on opposite sides of the vehicle.

Material handling unit or bucket 18 is pivoted on the outer end of boom 14 through unit ram 32 cooperating with a parallelogram linkage that consists of links 34 and 36 pivotally interconnected at 38 and respectively pivotally connected at 40 to the material handling unit and at 42 to lift arm 14. Fluid ram 32 consists of cylinder 50, trunion mounted on link 36 with piston rod 52 pivotally connected on lift arm 14 by pivot pin 54. Two unit rams 32 and links 34 and 36 are incorporated into the circuit and cooperate with the respective lift arms 14.

The hydraulic circuit for supplying fluid to boom rams 22 and unit rams 32 is shown schematically in FIG. 2. The hydraulic circuit includes reservoir 60 and pump means or main pump 62 cooperating with reservoir 60 for supplying fluid under pressure to rams 22 and 32. The hydraulic circuit includes first conduit 64 connecting pump means 62 to valve bank 66 and second conduit 68 connecting reservoir 68 to valve bank 66. The hydraulic circuit also includes first hydraulic circuit means 70 connecting valve bank 66 to boom rams 22 and second hydraulic circuit means 72 connecting valve bank 66 to unit rams 32.

First hydraulic circuit means 70 includes boom valve means 74, forming part of valve bank 66, and first and second conduits 76, 78 connected to opposite ends of cylinders 24. Second hydraulic circuit means 72 includes unit valve means 80 and first and second conduits 82, 84 connected to opposite ends of cylinders 50 forming part of unit rams 32.

With the hydraulic circuit so far described, actuation of boom valve means 74 in either direction from the neutral position will connect conduits 64 and 68 to conduits 76 and 78 to extend and retract piston rods 28 thereby raising and lowering boom 14 with respect to vehicle 10.

Likewise, actuation of unit control valve means 80 in opposite direction from neutral position will connect conduits 64 and 68 to conduits 82 and 84 thereby extending and retracting piston rods 52 with respect to cylinders 50 to pivot material handling unit 18 with respect to the boom.

As was indicated above, during the raising of the boom relative to the vehicle, when the material handling unit is filled with material, it is necessary to constantly reposition the material handling unit while the boom is being raised to prevent the contents from being spilled. It will be appreciated that if the material handling unit is not constantly being repositioned, the attitude with respect to a reference plane will constantly be changing as the boom is raised and lowered.

The present invention provides a simple system that eliminates the need for having large and heavy pivotal connections, such as required in the "slave cylinders" system, and also eliminates the need for large links on the lift arms so that the operator's visibility is not effected by the present system. The system also has greater flexibility in the placement of components for the system.

The present system to be described also maintains the advantage of other hydraulic self-leveling systems and, at the same time, insures that there is always sufficient fluid available for performing the leveling as well as the lifting functions.

According to the present invention, the hydraulic circuit incorporates an auxiliary hydraulic circuit that becomes operative at any time the boom is raised and lowered to produce a separate source of fluid for the unit rams to perform the self-leveling function. With reference to FIG. 2, auxiliary hydraulic circuit means 100 is incorporated into the hydraulic circuit and cooperates with first hydraulic circuit means 70 for supplying fluid from reservoir 60 to unit ram 32 and the fluid supplied thereto is capable of maintaining a predetermined attitude of the material handling unit with respect to a fixed reference plane as the boom is raised and lowered on the vehicle.

Auxiliary hydraulic circuit means 100 includes reversible auxiliary pump 102 having opposite sides or ports connected to reservoir 60 through first and second conduits 104 and 106. First and second conduits 104 and 106 each having unidirectional check valve 108 incorporated therein to limit the flow of fluid in the respective conduits from reservoir 62 to opposite sides of auxiliary pump 102. Conduits 104 and 106 are also connected by conduits 110 and 112 to auxiliary valve 114 and each conduit, 110, 112 has check valve 116 to limit the flow of fluid in one direction leading from auxiliary pump 102 to auxiliary or leveling valve means 114. Auxiliary valve 114 is connected to first and sec-

and conduits 82 and 84 through further conduits 120 and 122 and is also connected to reservoir 60 through conduit 124.

According to the primary aspect of the present invention, auxiliary pump 102 is operated as a function of the flow of fluid in first hydraulic circuit means 70. This is accomplished by auxiliary motor 130 in one of conduits 76,78 with auxiliary motor 130 connected through shaft 132 to reversible auxiliary pump 102.

With the auxiliary circuit incorporated into the main hydraulic circuit as shown and described, reversible auxiliary pump will only be operated when fluid is flowing to and from boom rams 22. It will be appreciated that this arrangement substantially increases the service life of the auxiliary pump since the pump will only be operating at times when fluid is necessary for maintaining the unit or bucket level.

Auxiliary valve 114 is actuated in response to a change in angular position between material handling unit 18 and boom 14 while main unit control valve 80 is in the neutral position. The actuating means for auxiliary valve 114 may take any number of forms and a linkage system 150 has been illustrated. By way of example, and not of limitation, the means for actuating auxiliary valve 114 may be of the type illustrated in Horsch U.S. Pat. No. 3,534,881; Horsch U.S. Pat. No. 3,578,191 and Seaberg et al. U.S. application Ser. No. 58,588 filed July 27, 1970, all assigned to the assignee of the present invention.

The operation of the hydraulic circuit of the present invention will be described in connection with the method aspect of the present invention. The Pivoting of the boom on the vehicle and the material handling unit on the boom is accomplished by supplying fluid under pressure through pump 62 from reservoir 60 to first and second valves 74 and 80, which are selectively actuated to supply fluid under pressure to rams 22 and 32. The respective rams will pivot the boom on the vehicle and the material handling unit on the boom. At any time fluid is being supplied to boom rams 22, auxiliary motor 130 will drive auxiliary pump 102 in the appropriate direction to draw fluid from reservoir through either conduit 104 or 106 and supply this fluid under pressure through the other of the conduits to auxiliary valve 114. Auxiliary valve 114 is actuated when the angular position between boom 14 and material handling unit 18 is changed so that the fluid supplied to auxiliary valve 114 will be directed to either conduit 82,84 while the other of these conduits is connected to reservoir 60 through conduit 124.

As can be seen from the description, the auxiliary hydraulic circuit produces fluid under pressure for delivery to unit rams 32 only when such fluid is necessary for producing the self-leveling function. At other times, auxiliary pump 102 is in a stationary condition thereby substantially increasing the service life of the unit. Furthermore, only a small pump is necessary since the hydraulic fluid needed for the self-leveling function is rather small in comparison to the amount of fluid required for supplying hydraulic rams 22 and 32.

A slightly modified form of the invention is shown in FIG. 3 and like reference numerals have been applied to the same parts. The only distinction between the respective hydraulic circuits shown in FIGS. 2 and 3 is that unit control valve means 80a and auxiliary valve means 114a are incorporated into a single valve. This valve is of the commercially available type wherein unit

control valve 80a has a second midsection inlet 170 for receiving fluid from auxiliary pump 102 and directing this fluid through separate flow paths leading from inlet 170 to the respective conduits 82 and 84. Since the combined main and auxiliary valve is commercially available from companies such as Commercial Shearing Co., Youngstown, Ohio, no detailed description appears to be necessary.

Summarizing briefly, the present invention provides a simple and inexpensive manner for insuring that there is a constant supply of fluid for unit rams 32 to maintain a level condition or attitude for the unit with respect to a reference plane as the boom is raised and lowered.

I claim:

1. In a vehicle having a boom pivoted thereon; a boom ram for raising and lowering said boom on said vehicle; a material handling unit pivoted on said boom; a unit ram for pivoting said unit on said boom; and a hydraulic circuit for supplying fluid to said rams, said hydraulic circuit including a reservoir; pump means for supplying fluid under pressure from said reservoir; first hydraulic circuit means connecting said pump means and said reservoir to said boom ram to raise and lower said boom; second hydraulic circuit means connecting said pump means and said reservoir to said unit ram; and auxiliary hydraulic circuit means cooperating with said first hydraulic circuit means and connected to said second hydraulic circuit means for supplying fluid from said reservoir to said unit ram and maintaining a predetermined attitude of said unit with respect to a reference plane as said boom is raised and lowered on said vehicle, said auxiliary hydraulic circuit means including an auxiliary pump cooperating with said first hydraulic circuit means.

2. A vehicle as defined in claim 1, in which said first hydraulic means includes conduit means between said boom ram, said pump means and said reservoir; and in which said auxiliary hydraulic circuit means includes means in said conduit means for driving said auxiliary pump in response to fluid flow in said conduit means.

3. A vehicle as defined in claim 2, in which said means in said conduit means is an auxiliary motor having a shaft connected to said auxiliary pump.

4. A vehicle as defined in claim 2, in which said conduit means includes first and second conduits leading from said boom ram and said means in said conduit means includes a reversible auxiliary motor having a shaft connected to said auxiliary pump.

5. A vehicle as defined in claim 4, in which said auxiliary hydraulic circuit means includes conduits leading from said reservoir to opposite sides of said auxiliary pump with each conduit having check valve means providing unidirectional flow from said reservoir to said auxiliary pump.

6. A vehicle as defined in claim 5, in which said auxiliary hydraulic circuit means includes an auxiliary valve and first and second conduits leading from said opposite sides of said auxiliary pump to said auxiliary valve, said first and second conduits each having check valve means providing unidirectional flow from said auxiliary pump to said auxiliary valve.

7. A vehicle as defined in claim 1, in which said auxiliary pump is reversible and said auxiliary hydraulic circuit means includes an auxiliary valve having first and second conduits leading from said auxiliary valve to said unit ram; and conduit means between said auxiliary valve and opposite sides of said auxiliary pump, said

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conduit means having valve means providing unidirectional flow from opposite sides of said auxiliary pump to said auxiliary valve.

8. A vehicle as defined in claim 1, in which said second hydraulic circuit means includes a control valve having first and second conduits leading from control valve to said unit ram and conduit means connecting said auxiliary pump to said control valve.

9. A vehicle as defined in claim 1, in which said auxiliary pump is reversible, said first hydraulic circuit means includes first and second conduits leading from said boom ram, and said auxiliary hydraulic circuit means includes an auxiliary motor in one of said first and second conduits and connected to said auxiliary pump to drive said auxiliary pump in either direction in response to fluid flow in either direction in said one of said first and second conduits.

10. In combination with a vehicle having a boom supported thereon with a boom ram adapted to raise and lower said boom and a material handling unit pivoted on the boom by a unit ram, a hydraulic circuit including a reservoir; a main pump; boom valve means; unit valve means; conduit means connecting (1) said valve means to said main pump and reservoir, (2) said boom valve means to said boom ram and (3) said unit valve means

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to said unit ram; and an auxiliary pump cooperating with the conduit means between said boom valve means and said boom ram for supplying fluid for said unit ram only when said boom valve means is actuated to direct fluid to said boom ram.

11. The combination as defined in claim 10, in which said auxiliary pump is reversible, further including first and second conduits connected to opposite sides of said auxiliary pump to said reservoir, said conduits having check valve means providing unidirectional flow from said reservoir to opposite sides of said auxiliary pump.

12. The combination as defined in claim 11, and including further conduits connecting said first and second conduits to said unit valve means so that one of said first and second conduits supplies fluid from said reservoir to said auxiliary pump and the other of said first and second conduits supplies fluid from said auxiliary pump to said unit valve means when said boom valve means is moved from a neutral position.

13. The combination as defined in claim 11, including auxiliary valve means; and further conduits connecting said first and second conduits to said auxiliary valve means and said auxiliary means to said unit ram.

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